

# CM1015 ELECTRONIC COMPASS MODULE

COMPLETE DIRECTION DETECTION MODULE WITH  
MAGNETOMETER AND ACCELEROMETER

## General Description

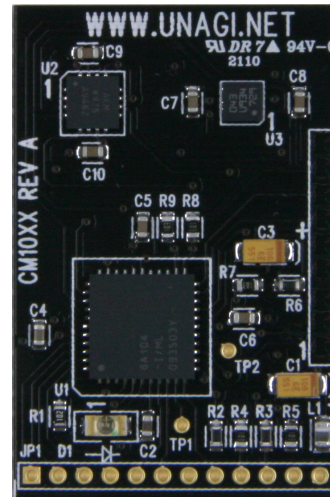
The CM1015 is a complete electronic compass module, that outputs accurate directional data without the need for manual calibration or additional components. Utilizing a 3 axis magnetometer along with a highly sensitive triaxial accelerometer, the CM1015 calculates it's position relative to terrestrial magnetism, and outputs it's direction in degrees. Gyroscopic output data is also available.

With it's built-in microprocessor core, the CM1015 automatically calibrates itself using patented algorithms, so that the module is always ready to operate correctly. Simply apply DC power to the module, and then read the appropriate registers to find it's direction. The module does all the detection and heavy calculations.

The CM1015 communicates via a simple serial communication port. The CM1015 only requires a single 3.3VDC power supply and is very low in power consumption (< 350mW).

The CM1015 module is very small in size, 1.0" x 1.5" x 0.13". This allows the module to be easily incorporated into handheld or other portable devices. The module contains a single 12-pin header which contains all the power and interface signals.

The CM1015 module is built with high-volume manufacturing techniques, to keep quality high and costs low. Each module is 100% tested with accuracy guaranteed.



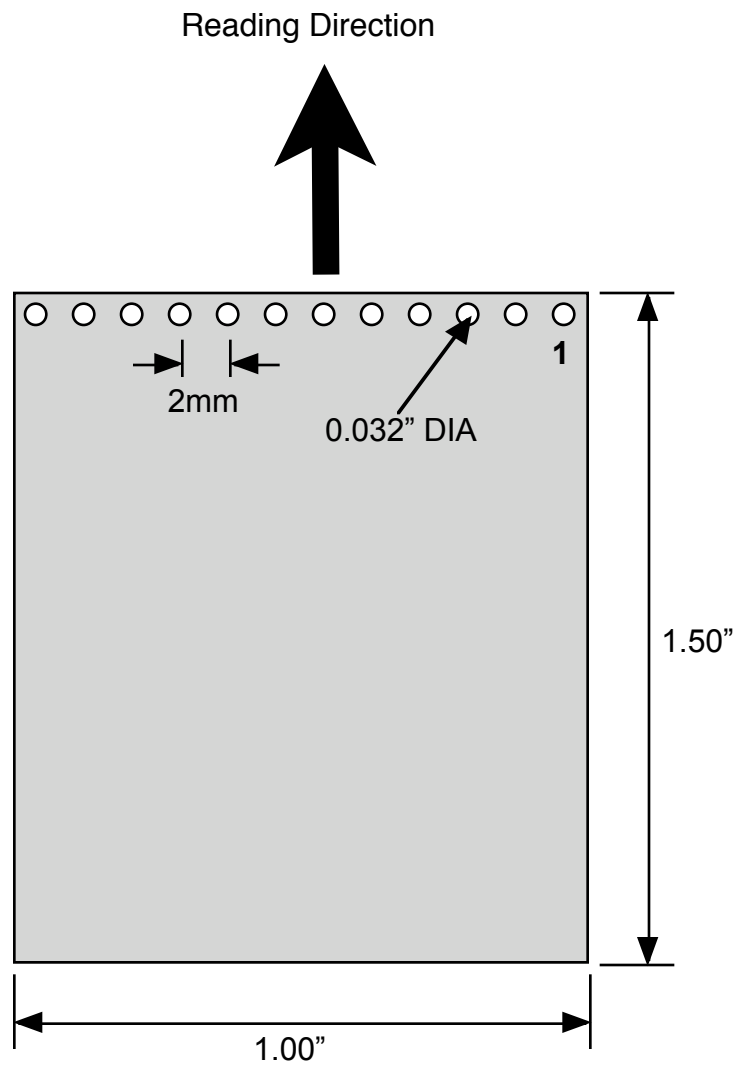
## Features

- Completely tested self-contained module  
No additional circuits or components required
- Patented Auto-Calibration  
No special equipment or methods required to calibrate for accurate direction detection
- Highly accurate direction detection  
Direction values from 0.0 to 359.9 degrees  
Includes Gyro data: Inclination, Pitch, Roll, Yaw
- Low-power consumption  
Ideal for battery operation
- Easy to interface  
Single DC supply and a simple serial interface.
- Compact size 1.0" x 1.5" x 0.13"  
Ideal for hand-held or other portable products

## Applications

- Automobile navigators
- Portable GPS mapping equipment
- Weather station loggers
- Construction equipment
- Marine mapping displays

MODULE OUTLINE



**PIN DESCRIPTIONS**

PIN #	NAME	DIRECTION	FUNCTION
1	I2CDAT	Open Collector	Non functional pin.*
2	I2CCLK	INPUT	Non functional pin.*
3	RSTX	OUTPUT	Non functional pin.*
4	RSRX	INPUT	Non functional pin.*
5	SREQ	INPUT	Serial Data Request
6	SDONE	OUTPUT	Serial Data Done
7	SDAT	OUTPUT	Serial Data
8	SCLK	OUTPUT	Serial Data Clock
9	MODE0	INPUT	Non functional pin.*
10	MODE1	INPUT	Non functional pin.*
11	VDD	POWER	MAIN VOLTAGE CONNECTION. 3.3VDC TYPICAL.
12	GND	POWER	MAIN GROUND CONNECTION.

\* - These pins are not used on the CM1015 module. Refer to the CM1010 module datasheet.

VDD, GND - These pins are the main module power connections. VDD typically is 3.3V. Bypass capacitors should be connected as close to these pins as possible.

### Absolute Maximum Ratings

Supply Voltage	-0.3V to 6V
Input Voltage	-0.3V to 6V
Voltage at all other pins	-0.3V to 5.5V
T <sub>MAX</sub>	100 C

### Recommended Operating Conditions

Voltages referenced to GND; GND = 0 V

Parameter	Symbol	Pin	Min	Typ	Max	Unit
Supply Voltage (1)	VDD	11	2.7	3.3	4.0	V
Input Voltage	V <sub>IN</sub>	2, 4, 5, 8, 9, 10	0.0	-	VDD	V
Output Current	I <sub>o</sub>	3, 7	-	-	3.0	mA
Temperature	T <sub>A</sub>		-30		+85	°C

(Note 1) Maximum supply voltage ramp-up time is 200uS.

## DC Characteristics

Voltages referenced to GND; GND = 0 V, VDD = 3.3V

Parameter	Symbol	Pins	Min	Typ	Max	Unit
Input Voltage Low	V <sub>IL</sub>	2, 4, 5, 8, 9, 10	GND	-	0.2 VDD	V
Input Voltage High	V <sub>IH</sub>	2, 4, 5, 8, 9, 10	0.8 VDD	-	VDD	V
Output Voltage Low	V <sub>OL</sub>	3, 7	-	-	0.4	V
Output Voltage High	V <sub>OH</sub>	3, 7	2.7	-	-	V
Open Collector Voltage - Low	V <sub>OCL</sub>	1	-	-	0.2 VDD	V
Open Collector Voltage - High	V <sub>OCH</sub>	1	0.8 VDD	-	-	V
Open Collector Resistance	V <sub>OCR</sub>	1	-	1.0 K	-	Ohm
Module Power Consumption	I <sub>DD</sub>	11	-	30	-	mA

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## Applications Information

### Power On

The CM1015 only requires power to begin operation. The module has a built-in reset and watchdog function, therefore all that is required is proper VDD to begin operation.

The maximum power ramp-up is 200uS. If power is applied at a slower ramp-up than 200uS, proper module initialization is not guaranteed and operations may be erratic.

### Serial Communication

The CM1015 communicates over a serial port with various control signals. Please refer to the Serial Communication section for additional information on the exact timing signals required.

### Direction North

The module facing direction is from the top edge of the module.

### Automatic Calibration

The CM1015 has an automatic self-calibration function that operates once the power is applied, and continuously thereafter on a regular basis. The magnetic axis self-calibration is performed when the module is rotated through positions during normal use. No other action is necessary for the module to calibrate to the terrestrial magnetism of the surrounding environment.

**Serial Communication**

The CM1015 module uses simple 2-wire serial communication to send out the present direction data of the module. The module acts as a Master data device, that outputs data and clock signals. Two control signals are also available that control the flow of the data coming out of the module.

PIN	NAME	DIRECTION	FUNCTION
5	SREQ	INPUT	Serial Data Request, active low
6	SDONE	OUTPUT	Serial Data Done, active high
7	SDAT	OUTPUT	Serial Data
8	SCLK	OUTPUT	Serial Data Clock

SDAT, Serial Data –  
This is the main serial data output pin.

SCLK, Serial Data Clock –  
This is a clock signal that is used to indicate when the Serial Data is valid. The Serial Data is valid on the rising edge of this Serial Data Clock pin.

SDONE, Serial Data Done – Active HIGH  
When the entire packet of direction data has been clocked out of the module, this pin will go high to indicate that the direction data packet has finished being output.

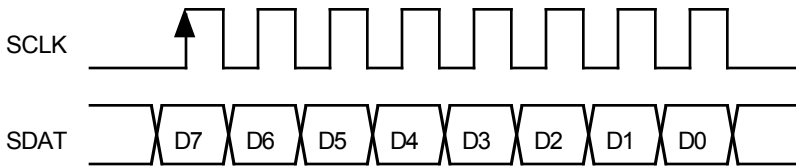
SREQ, Serial Data Request – Active HIGH  
A high signal on the SREQ pin will tell the module that it should go acquire new direction data. This pin should be HIGH for 10uS minimum.

The serial communication handshake flow is detailed out in the Timing Diagrams. The signal ordering is as follows:

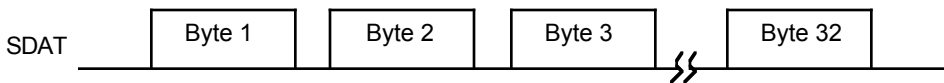
- from idle condition : SDONE = HIGH, SREQ = LOW.
- Take SREQ high; requests new data from module.
- Wait for SDONE to go low.
- SDONE goes low; new data will begin clocking out.
- Take SREQ low; idle condition.
- Wait for SDONE to go high; indicates all data has been clocked out.
- SDONE is high; idle condition.

Timing Diagrams

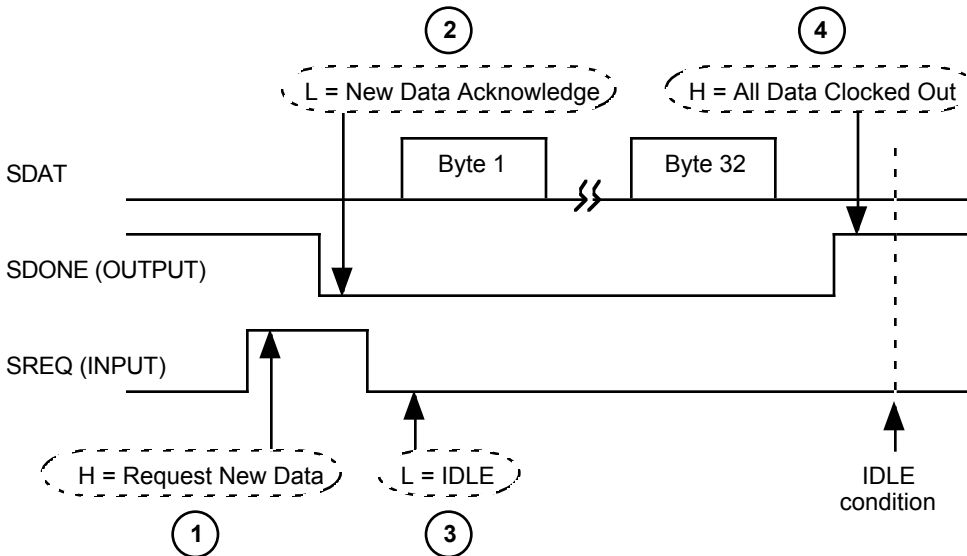
Output data and clock timing:



Output data byte ordering:



Output handshaking:





## Applications Information

### Data Format

The data that the CM1015 outputs is grouped into a 32 byte packet. The packet details are outlined below:

Name	Output Byte	Description	Bits	Info
IDU	00	Packet Header	8	Upper byte of identification packet
IDL	01	Packet Header	8	Lower byte of identification packet
COMXU	02	Raw Compass Data X	8	Upper byte of the raw compass X-axis data
COMXL	03	Raw Compass Data X	8	Lower byte of the raw compass X-axis data
COMYU	04	Raw Compass Data Y	8	Upper byte of the raw compass Y-axis data
COMYL	05	Raw Compass Data Y	8	Lower byte of the raw compass Y-axis data
COMZU	06	Raw Compass Data Z	8	Upper byte of the raw compass Z-axis data
COMZL	07	Raw Compass Data Z	8	Lower byte of the raw compass Z-axis data
ACCXU	08	Raw Accelerometer Data X	8	Upper byte of the raw accelerometer X-axis data
ACCXL	09	Raw Accelerometer Data X	8	Lower byte of the raw accelerometer X-axis data
ACCYU	0A	Raw Accelerometer Data Y	8	Upper byte of the raw accelerometer Y-axis data
ACCYL	0B	Raw Accelerometer Data Y	8	Lower byte of the raw accelerometer Y-axis data
ACCZU	0C	Raw Accelerometer Data Z	8	Upper byte of the raw accelerometer Z-axis data
ACCZL	0D	Raw Accelerometer Data Z	8	Lower byte of the raw accelerometer Z-axis data
HEADL	0E	Heading	8	Lower byte of the calculated heading
HEADU	0F	Heading	8	Upper byte of the calculated heading

Name	Output Byte (hex)	Description	Bits	Info
INCL	10	Inclination	8	Lower byte of the calculated inclination
INCW	11	Inclination	8	Upper byte of the calculated inclination
MAGL	12	Magnitude	8	Lower byte of the calculated magnitude
MAGW	13	Magnitude	8	Upper byte of the calculated magnitude
IDIRL	14	Initial Direction	8	Lower byte of the calculated initial direction
IDIRW	15	Initial Direction	8	Upper byte of the calculated initial direction
PITL	16	Pitch	8	Lower byte of the calculated pitch
PITW	17	Pitch	8	Upper byte of the calculated pitch
ROLL	18	Roll	8	Lower byte of the calculated roll
ROLW	19	Roll	8	Upper byte of the calculated roll
YAWL	1A	Yaw	8	Lower byte of the calculated yaw
YAWW	1B	Yaw	8	Upper byte of the calculated yaw
---	1C	no data	8	no valid data - all values zero
---	1D	no data	8	no valid data - all values zero
---	1E	no data	8	no valid data - all values zero
---	1F	no data	8	no valid data - all values zero

• **Byte 00 – IDU (Packet Header, Upper byte)**

IDU							
7	6	5	4	3	2	1	0
1	0	1	0	0	0	0	0

BITS 7-0 ID (7:0) : Packet Start ID = A0h

• **Byte 01 – IDL (Packet Header, Lower byte)**

IDL							
7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	1

BITS 7-0 ID (7:0) : Packet Start ID = 01h

• **Byte 02 – COMXU (Raw Compass Data, X-axis, Upper byte)**

• **Byte 03 – COMXL (Raw Compass Data, X-axis, Lower byte)**

COMXU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 COMXU (7:0) : Upper byte of the raw compass data, in the X-axis

COMXL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 COMXL (7:0) : Lower byte of the raw compass data, in the X-axis

- **Byte 04 – COMYU (Raw Compass Data, Y-axis, Upper byte)**
- **Byte 05 – COMYL (Raw Compass Data, Y-axis, Lower byte)**

COMYU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

**BITS 7-0**      **COMYU (7:0)** : Upper byte of the raw compass data, in the Y-axis

COMYL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

**BITS 7-0**      **COMYL (7:0)** : Lower byte of the raw compass data, in the Y-axis

- **Byte 06 – COMZU (Raw Compass Data, Z-axis, Upper byte)**
- **Byte 07 – COMZL (Raw Compass Data, Z-axis, Lower byte)**

COMZU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

**BITS 7-0**      **COMZU (7:0)** : Upper byte of the raw compass data, in the Z-axis

COMZL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

**BITS 7-0**      **COMZL (7:0)** : Lower byte of the raw compass data, in the Z-axis

- **Byte 08 – ACCXU (Raw Accelerometer Data, X-axis, Upper byte)**
- **Byte 09 – ACCXL (Raw Accelerometer Data, X-axis, Lower byte)**

ACCXU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

**BITS 7-0 ACCXU (7:0) :** Upper byte of the raw accelerometer data, in the X-axis

ACCXL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

**BITS 7-0 ACCXL (7:0) :** Lower byte of the raw accelerometer data, in the X-axis

- **Byte 0A – ACCYU (Raw Accelerometer Data, Y-axis, Upper byte)**
- **Byte 0B – ACCYL (Raw Accelerometer Data, Y-axis, Lower byte)**

ACCYU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

**BITS 7-0 ACCYU (7:0) :** Upper byte of the raw accelerometer data, in the Y-axis

ACCYL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

**BITS 7-0 ACCYL (7:0) :** Lower byte of the raw accelerometer data, in the Y-axis

- **Byte 0C – ACCZU (Raw Accelerometer Data, Z-axis, Upper byte)**
- **Byte 0D – ACCZL (Raw Accelerometer Data, Z-axis, Lower byte)**

ACCZU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

**BITS 7-0 ACCZU (7:0) :** Upper byte of the raw accelerometer data, in the Z-axis

ACCZL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

**BITS 7-0 ACCZL (7:0) :** Lower byte of the raw accelerometer data, in the Z-axis

- **Byte 0E – HEADU (Calculated Heading, Upper byte)**
- **Byte 0F – HEADL (Calculated Heading, Lower byte)**

HEADU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

**BITS 7-0 HEADL (7:0) :** Upper byte of the calculated heading

HEADL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

**BITS 7-0 HEADU (7:0) :** Lower byte of the calculated heading

HEADU & HEADL combine to show the pointed direction in degrees x 10.

For example, a value of hex 055F, which is decimal 1375, indicates a heading of 1375/10, which is 137.5 degrees.

- **Byte 10 – INCL (Calculated Inclination, Lower byte)**
- **Byte 11 – INCU (Calculated Inclination, Upper byte)**

INCL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0      INCL (7:0) : Lower byte of the calculated inclination

INCU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0      INCU (7:0) : Upper byte of the calculated inclination

Inclination is the path of the terrestrial magnetic field, which varies depending on your location.

- **Byte 12 – MAGL (Calculated Magnitude, Lower byte)**
- **Byte 13 – MAGU (Calculated Magnitude, Upper byte)**

MAGL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0      MAGL (7:0) : Lower byte of the calculated magnitude

MAGU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0      MAGU (7:0) : Upper byte of the calculated magnitude

Magnitude is the amount of magnetic flux being detected by the module. This will vary depending on the module’s position and the operating environment.

- **Byte 14 – IDIRL (Calculated Initial Direction, Lower byte)**
- **Byte 15 – IDIRU (Calculated Initial Direction, Upper byte)**

IDIRL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 IDIRL (7:0) : Lower byte of the calculated initial direction

IDIRU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 IDIRU (7:0) : Upper byte of the calculated initial direction

Initial direction shows the position the module was pointing when power was applied.

- **Byte 16 – PITL (Calculated Pitch, Lower byte)**
- **Byte 17 – PITU (Calculated Pitch, Upper byte)**

PITL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 PITL (7:0) : Lower byte of the calculated pitch

PITU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 PITU (7:0) : Upper byte of the calculated pitch



- **Byte 18 – ROLL (Calculated Roll, Lower byte)**
- **Byte 19 – ROLU (Calculated Roll, Upper byte)**

ROLL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0      ROLL (7:0) : Lower byte of the calculated roll

ROLU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0      ROLU (7:0) : Upper byte of the calculated roll

- **Byte 1A – YAWL (Calculated Yaw, Lower byte)**
- **Byte 1B – YAWU (Calculated Yaw, Upper byte)**

YAWL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0      YAWL (7:0) : Lower byte of the calculated yaw

YAWU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0      YAWU (7:0) : Upper byte of the calculated yaw

- Byte 1C - (No Data)
- Byte 1D - (No Data)
- Byte 1E - (No Data)
- Byte 1F - (No Data)

(No Data)							
7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0

BITS 7-0 (No Data) (7:0) : Data = 00h